

REMARKS

Claims 1, 16, 44, 45 and 48 have been amended. Claim 47 has been withdrawn. Claims 1-8, 16-20, 40-46, 48, 49, and 50 are pending in the application. No new matter has been introduced by the amendments.

Claims 14, 6-8, 16-20, 40, 44, 45, 46, 48, and 49 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,780,666 (McClure) in view of U.S. Patent No. 6,362,040 (Tews). The rejection is respectfully traversed.

The present invention is directed to an imaging device pixel cell having a halogen-rich region formed therein for suppressing dark current in a photosensor. Accordingly, independent claim 1, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate [and] an isolation region formed within said substrate and adjacent to said photosensor.” Claim 1 further recites that the pixel cell has “a halogen-rich region localized at least at a sidewall region and a bottom portion of said isolation region.”

Independent claim 16, as amended, recites a pixel cell having “a semiconductor substrate having trenches formed therein [and] a photosensor formed in said substrate and having a first doped region and a second doped region in association with said semiconductor substrate, said photosensor being capable of generating dark current.” Claim 16 further recites the pixel cell having “a halogen-rich region formed within at least one of said trenches for the suppression of said dark current; and an isolation region formed within said at least one trench.”

Independent claim 44, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate [and] a shallow trench isolation region formed within said substrate and adjacent to said photosensor.” Claim 44 further recites the pixel cell having “a fluorine-rich region localized at a boundary between said shallow trench isolation region and said substrate.”

Independent claim 45, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate; a

shallow trench isolation region formed within said substrate; and; and a halogen-rich region localized throughout a surface of said substrate that contacts said shallow trench isolation region for suppressing the flow of dark current from said photosensor.”

Independent claim 48, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate; an isolation region formed within a trench formed within said substrate; and a halogen-rich region localized within said trench for suppressing the presence of charge collecting dangling bonds of said substrate at said trench.”

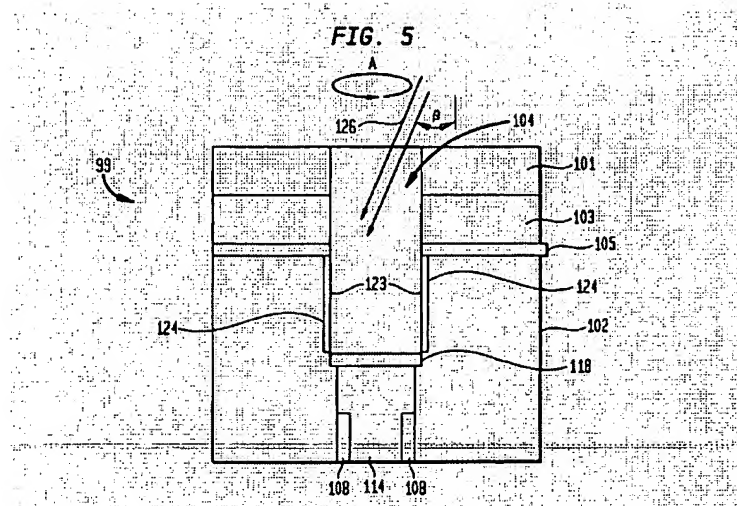
McClure relates to an imaging device having a pixel with two capacitors in series. (Abstract). McClure fails to teach each and every limitation of claims 1, 16, 44, 45, and 48 as admitted by the Office Action at Page 3, ¶ 2. The Office Action attempts to combine McClure with Tews to allegedly arrive at the claimed invention. Tews relates to the fabrication of memory devices and transistors. Specifically, Tews relates to “a method for growing a dielectric layer on a substrate [by] . . . providing a substrate having at least two crystallographic planes which experience different dielectric layer growth rates.” (Abstract). The different growth rates are a result of doping the surface at which the thermal oxide is intended to be grown. Tews, col. 7, ll. 18-27.

The Office Action engages in impermissible hindsight in combining the two references. Courts have generally recognized that a showing of a prima facie case of obviousness necessitates three requirements: (i) some suggestion or motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine the reference teachings; (ii) a reasonable expectation of success; and (iii) the prior art references must teach or suggest all claim limitations. *See e.g., In re Dembiczak*, 175 F.3d 994 (Fed. Cir. 1999); *In re Rouffet*, 149 F.3d 1350, 1355 (Fed. Cir. 1998); *Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc.*, 75 F.3d 1568, 1573 (Fed. Cir. 1996); and MPEP §§ 706.02(j) and 2143 *et seq.* Furthermore, the “[t]he teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant’s disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).” MPEP §706.02(j).

The Office Action fails to provide any suggestion or motivation to combine the two references, as required by MPEP §§ 706.02(j) and 2143 *et seq.* Instead, the Office Action merely makes the assertion that “it would have been obvious to one of ordinary skill in the art at the time the invention was made to have a halogen-rich region for oxidizing trench sidewalls which reduces crystallographic orientation dependence.” (Office Action at 3, ¶3). As discussed above, Tews dopes a localized surface of a silicon substrate to vary the growth rates at which thermal oxide will grow. Tews, col. 7, ll. 18-27. It would not have been obvious to one of ordinary skill in the art to combine Tews with McClure, as McClure relates to an imaging device having a pixel cell with two capacitors in series.

Significantly, neither reference is directed to the problem of dark current generation in an imaging device, or the use of a halogen-rich region to suppress dark current. McClure relates to increasing the capacitance of a charge collection region, and Tews relates to varying the growth rate of a substrate at different surfaces. Neither reference even mentions the problem of the present invention addresses, namely, dark current generation in an imaging device pixel cell.

Even if the references could be combined, however, the cited references, alone or in combination, fail to teach or suggest each and every limitation of independent claim 1. As illustrated by FIG. 5 of Tews (reproduced below), Tews discloses “low energy angled ion implantation . . . employed to direct dopants (ions) 126 to damage the [sic] surface of sidewalls 123.” Tews, col. 5, ll. 32-35. Tews further states that “dopants 126 are self-aligned to sidewalls 123, since other areas are masked by hard mask 101 or trench top layer 118.” *Id.* at col. 6, ll. 1-3. Accordingly, Tews, alone or in combination with McClure, does not teach or suggest “a halogen-rich region localized at least at a sidewall region and a bottom portion of said isolation region,” as recited by claim 1.



Similarly, for the reasons set forth above with respect to claim 1, Tews, alone or in combination with McClure, fails to teach or suggest a pixel cell having “a halogen-rich region formed within at least one of said trenches for the suppression of said dark current; and an isolation region formed within said at least one trench,” as recited by independent claim 16.

For the reasons set forth above with respect to claim 1, Tews, alone or in combination with McClure, fails to teach or suggest a pixel cell having “a fluorine-rich region localized at a boundary between said shallow trench isolation region and said substrate,” as recited by independent claim 44.

For the reasons set forth above with respect to claim 1, Tews, alone or in combination with McClure, fails to teach or suggest a pixel cell having “a halogen-rich region localized throughout a surface of said substrate that contacts said shallow trench isolation region for suppressing the flow of dark current from said photosensor,” as recited by independent claim 45.

For the reasons set forth above with respect to claim 1, Tews, alone or in combination with McClure, fails to teach or suggest a pixel cell having “a halogen-rich region localized within said trench for suppressing the presence of charge collecting dangling bonds of said substrate at said trench,” as recited by independent claim 48.

Accordingly, Applicant respectfully submits that independent claims 1, 16, 44, 45, and 48 are allowable over the combination of McClure and Tews. Dependent claims 2-8, 17-20,

40-43, 46, 49, and 50 depend from independent claims 1, 16, 44, 45, and 48, and are allowable for at least the reasons set forth above, and on their own merit.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

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Respectfully submitted,

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